SERVICE INSTRUCTIONS

section CA

ANCILLARY FREQUENCY SOURCE, AFS-1

P/N 1160-4010

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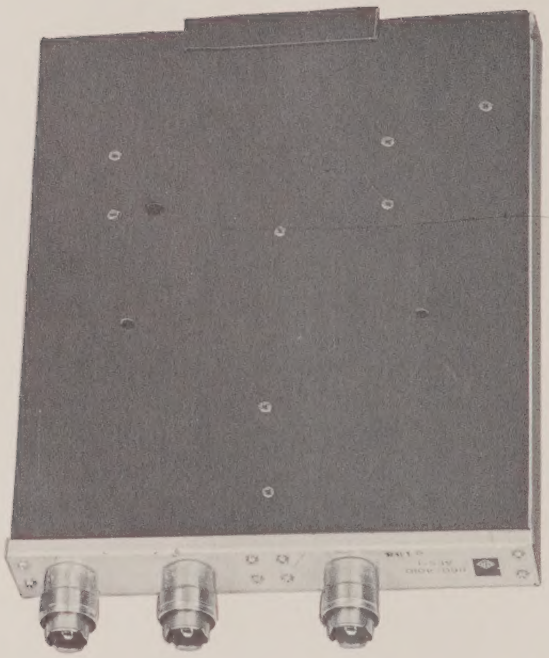


Ancillary Frequency Source – AFS-1.

SECTION CA-1

INTRODUCTION

CA-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension by experienced service personnel of the principles of operation. A trouble-analysis procedure that will aid in the isolation of defective circuits completes the section.

To facilitate part identification, reference designators used in the text and on the photographs are the same as those used on the complete schematic diagram and in the parts list. The reference designators are silk-screened on the module as a further aid in part location.

The service instructions rely on the use of an otherwise properly functioning synthesizer as a basic test frame for the suspect module. The instrument can be used to support the module in a convenient bench-service position and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the wide spread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

CA-1.2 PURPOSE.

The Ancillary Frequency Source (hereafter referred to as AFS) is the electrical starting point for all General Radio frequency synthesizers. Its purpose is to furnish the frequency reference for the entire instrument. The AFS accomplishes this either by the processing of an external signal for use as the reference frequency standard for the instrument, or by provision of an internal source for this reference, at the user's option. It also supplies a selected group of fixed frequencies, coherently derived from the reference, for use in, and (optionally) external to, the remainder of the frequency synthesizer.

The AFS module plugs into the lower section of the main sandwich deck, at the left-hand side of the instrument. It engages 11 banana plugs projecting from the sandwich deck. From these interconnections, power is applied to the AFS through 2 plugs and output signals are taken from the AFS through the remaining 9. Electrical ground connection is made by physical contact between the AFS and the sandwich, when the two large mounting screws are in place.

CA-1.3 DESCRIPTION.

CA-1.3.1 MECHANICAL LAYOUT.

The AFS module is an assembly of three etched-circuit boards that contain all of the electrical parts in the AFS circuitry. Along the perimeters of the etched boards are sheet-metal rails that provide electrical shielding and mechanical support for the entire assembly. The three boards are attached to each other and to the rear panel by machine screws.

The rear panel carries three GR874 connectors, two of which give access to fixed output frequencies – 5 Mc/s and 100 kc/s; the third is an input connector for an external lock signal (if used).

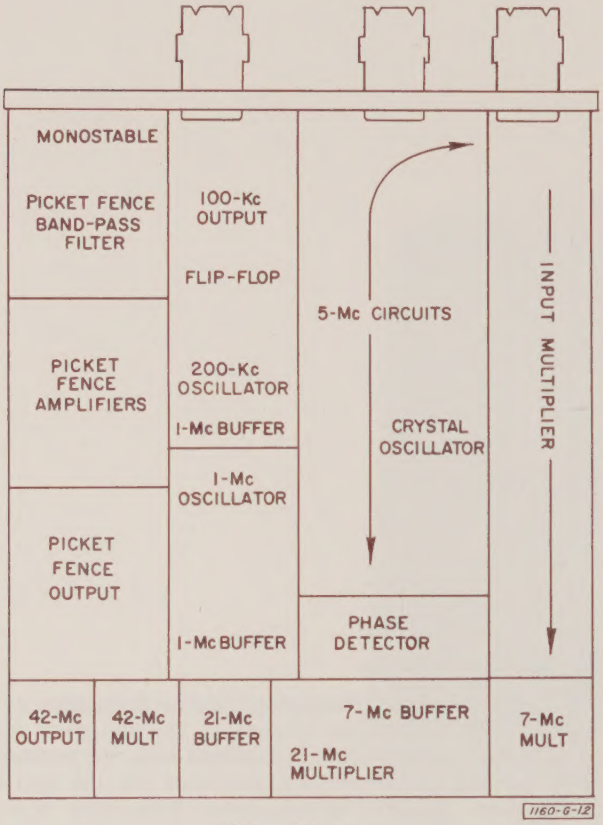


Figure CA-1.
Functional layout diagram for AFS-1 (viewed from component side).

A one-piece sheet-metal cover slides over the front of the module for electrical shielding, physical protection, and additional mechanical support. The internal adjustments are affected negligibly by the presence or absence of the cover; except for stray signal pickup, the AFS can function with or without it. Thus, alignment can be performed with the cover removed. When in place on the Main Frame assembly, the foil sides of the circuit boards face the sandwich deck and the detail parts are accessible for adjustment, if required in the service procedure.

The mounting screws for the unit are two 10-32 x 1-3/8-inch Phillips-head screws projecting through bushings near the centers of the two larger boards in the AFS. They screw into threaded inserts in the sandwich deck.

Interconnections between the etched boards are made by wire links on the foil side. A short length of miniature coaxial cable is also used and is soldered into eyelets on the etched boards.

Reference to the pictorial layout of Figure CA-1 shows the location of various circuits in the module; signal flow is also indicated. The circuits are divided and positioned to provide maximum isolation, logical signal flow, and minimum interconnection between etched boards.

CA-1.3.2 ELECTRICAL CHARACTERISTICS.

The AFS module contains the master oscillator, from which are derived all frequencies in the synthesizer (except for the free-running continuously adjustable oscillators in the CAD unit). Table CA-1 lists the outputs of the AFS unit. See the over-all schematic in Sections BA or BB for the interconnecting wiring by which the outputs are distributed throughout the synthesizer.

TABLE CA-1

DIRECT OUTPUT FREQUENCIES

Frequency	*Source*	*Available*	*Used by*	*Approximate Level*
5.0 Mc/s	Crystal Oscillator in AFS	J106	DI-1 (Station 7) CAD	1 V into 50Ω
		J104	Output Mixer Units	300 mV into 1 kΩ
		J108	For optional external use.	1 V behind 50Ω
1.0 Mc/s	Divided from 5.0 Mc/s	J201	DI-4 unit, when present	1 V into 1 kΩ
100 kc/s	Divided from 1 Mc/s	J206	For optional external use	1 V behind 50Ω
42 Mc/s	Multiplied from 1.0 Mc/s	J301	DI-1 units and CAD unit	1 V into 100Ω
Picket Fence 10 frequencies 100-kc spacing 3.0 – 3.9 Mc/s	Selected group of harmonics of 100 kc/s	J203 J204 J205	DI-1 units	400 mV into 7Ω per component

An input jack, J101, on the AFS module accepts a dc voltage from the front-panel potentiometer (R407) labeled CRYSTAL FREQ. This voltage is fed to a varactor diode in the crystal-oscillator circuit to control the crystal frequency by small amounts.

In addition, circuits are available in the AFS to lock the internal 5-Mc quartz oscillator to an equivalent (or superior) external standard. This feature allows any one of the several commonly available frequencies from standard-frequency-distribution systems to be fed into the synthesizer. Thus, the user can reference his synthesizer output to his own laboratory standard, or other equivalent laboratory instrument. Alternatively, the internally derived 5-Mc and the 100-kc signals are available from J108 and J206 to reference other instruments to the synthesizer.

The GR locking circuit will operate from any standard frequency from 100 kc/s to 5 Mc/s (with an amplitude between 0.25 and 5 volts, rms), provided that the frequency is an integral submultiple of 5 Mc/s. This signal must be fed into J107, a GR874 connector at the rear of the AFS unit, marked LOCK SIG IN. An automatic frequency multiplier chooses the harmonic number necessary to multiply the external reference frequency to 5 Mc/s. The resulting signal is fed to a phase detector, whose output signal locks the internal 5-Mc quartz oscillator to the external reference.

The CRYSTAL FREQ control mentioned above, when used with an external reference, can bring the internal crystal-oscillator frequency close enough to the external standard so that the quartz oscillator is captured and locked. The phase-detector error signal is brought out of the AFS (via J103) to deflect the front-panel monitor meter, when the MONITOR switch is set to LOCK TO EXT STD to show the condition of the phase lock.

SECTION CA-2

PRINCIPLES OF OPERATION

CA-2.1 GENERAL.

In this section, reference will be made to the schematic diagrams as noted: Figure CA-9 is the functional block diagram of the entire module, while the three etched-board diagrams are separate. Figure CA-10 shows the Master Frequency Section, Figure CA-11 the Picket-Fence Section, and Figure CA-12 the 42-Mc Multiplier Section.

NOTE

The figures are foldout diagrams at the end of this section.

In the elementary schematic diagram, the unit block diagram is seen divided into its three boards, with the circuits contained on each separated from one another.

CA-2.2 MASTER FREQUENCY SECTION (Figure CA-10).

The starting point of the system is the 5-Mc crystal oscillator stage, Q109. This circuit and all other 5-Mc circuits are on the Master Frequency Section board, one of the large boards (1160-0750/X). The circuit is a modified Clapp-Gouriet circuit with a varactor diode, CR104, representing part of the load capacitance of the AT-cut, hermetically sealed, room-temperature, quartz plate. A nominal 4 Vdc is supplied to the cathode of the varactor, through the phase detector, from the front-panel CRYSTAL FREQ control. When the phase detector is in operation, as described below, the dc-control voltage from the phase detector is added algebraically to the dc voltage fed in at J101, to keep the crystal-oscillator frequency equal to that of the input reference.

Q109 feeds a common-base, tuned buffer-amplifier, Q110. The output from Q110 is fed to the output jack, J104, which feeds the Output Mixer Module, OM-1 in the Type 1161 synthesizer, and OMM-1 or OMM-2 in the Type 1162 or 1163 synthesizers, respectively. Another output from the buffer feeds the amplifier, Q111, and emitter-follower, Q113. The emitter-follower output is adjustable (R152) to select the proper drive to Q114 and Q115, the high-level 5-Mc amplifiers. The Q114 amplifier feeds the input to the first DI-1 module in the synthesizer chain and the 5-Mc input to the CAD. The Q115 amplifier provides the 5-Mc signal to J108 for external use.

Q111, the common-emitter amplifier referred to above, feeds signals to the phase-detector drive amplifier, Q112, and the 1-Mc injection-locked oscillator on the Picket-Fence Section, described in paragraph CA-2.3. The push-pull side of the 5-Mc Phase Detector is driven by Q112. In the absence of a 5-Mc signal at the external-reference side of the phase detector (junction of the two diodes, CR105 and CR106), no dc voltage appears on the frequency-control line, except that present at J101.

The circuits associated with transistors Q101 through Q108 are part of the external-reference-frequency system described in paragraph CA-1.3.2. The input signal fed into J107 is clipped by the limiting diodes CR101 and CR102, if the level is more than about 1.2 volts, peak-to-peak. This signal is then fed to an amplifier, Q101, which drives the Schmitt circuit, Q102 and Q103.

The current pulse, developed by the Schmitt trigger from the zero crossings of the input signal, is fed to the pulse shaper, comprised of L102 and C103 and resonant at approximately 5 Mc/s, and a

shunt diode, CR103. The diode prevents the tuned circuit from resonating for more than one-half cycle of the LC resonant frequency. The resulting half-sine-wave pulse contains a strong 5-Mc component, which drives the normally-off pulse amplifier, Q104. The amplified pulse drives a double-tuned, critically coupled pair of 5-Mc tuned circuits, used to accentuate the 5-Mc signal and suppress unwanted sidebands.

This signal, with an envelope whose repetition rate is the same as the repetition rate of the frequency entering the LOCK SIG IN jack (J107), is used to drive the emitter-follower/Schmitt-trigger combination Q105, plus Q106 and Q107. The character of the signal output from the 5-Mc filter, L104 and L105, is such that there is always sufficient signal to operate the Schmitt circuit (without loss of any trigger pulses), even with input frequencies to J107 as low as 100 kc/s. Thus, the Schmitt circuit produces at its output a 5-Mc square wave independent of the level at the filter, and provides, thereby, a constant-level 5-Mc signal to drive Q108. The Q108 amplifier stage drives the diode side of the 5-Mc Phase Detector. Presence of this signal activates the phase detector and furnishes the feedback signal that controls the internal quartz oscillator.

CA-2.3 PICKET-FENCE SECTION (Figure CA-11).

The second large etched board in the AFS, called the Picket-Fence Section (1160-0760/X), contains all of the circuits required in generation of the picket-fence frequency band, plus the dividers to develop this frequency band proportionally from 5 Mc/s.

The division from 5 Mc/s to 1 Mc/s and from 1 Mc/s to 200 kc/s is accomplished through the use of oscillators injection-locked from the higher frequencies. The 200-kc to 100-kc division is effected by a simple flip-flop divider (Q207/Q208).

The 5-Mc signal from Q111 via T103, mentioned in paragraph CA-2.2, feeds a two-transistor injection-locked oscillator (Q201 and Q202). The circuit is an emitter-coupled, transistor-switch pair, so connected that only one transistor conducts at a time. A 1-Mc tank is in series with the collector of Q202. Part of the signal from this collector is fed to the base of Q201 (via C202), closing the loop on this oscillator circuit. The current waveforms in each transistor are square wave. Transistor Q201, loaded with resistor R201, gives a direct, independent square-wave voltage output. The base of Q202, which is not directly in the oscillator loop, accepts the 5-Mc voltage fed to it from the Q111/T103 amplifier (see Figure CA-9). It then locks this oscillator in a manner that makes its 1-Mc output exactly one-fifth of the 5-Mc signal being fed to it, by controlling the point at which the two transistors switch. The two outputs of this 1-Mc oscillator feed two amplifiers, Q203 and Q204, separately.

The Q204 amplifier, which operates from the square-wave output, isolates the 1-Mc oscillator (Q201 and Q202) from a similar 200-kc oscillator (Q205 and Q206). The action of this 200-kc oscillator is identical to the one described above, except that no sine-wave output is taken from it. The 200-kc square-wave output drives a flip-flop circuit (Q207 and Q208) whose two separate 100-kc outputs drive the remaining circuits on this board.

One of the outputs from the flip-flop feeds Q209, a tuned buffer which furnishes a 100-kc sine-wave output for external use. The other 100-kc output drives the picket-fence-forming circuit.

The core-element in the Picket-Fence Section is the monostable pulse generator, Q211 and Q212, driven by pulse amplifier Q201. In the circuits driven by this generator, the appropriate harmonics of 100 kc/s are enhanced, while some of the unwanted harmonics are suppressed.

The 100-kc rectangular-pulse train emanating from the pulse generator contains harmonics of 100 kc/s, which have an amplitude charateristic whose envelope is described by the $\frac{\sin x}{x}$ function.

The positions of the nulls depend on the ratio of t_i/T_o (see Figure CA-2). In the Picket-Fence gen-

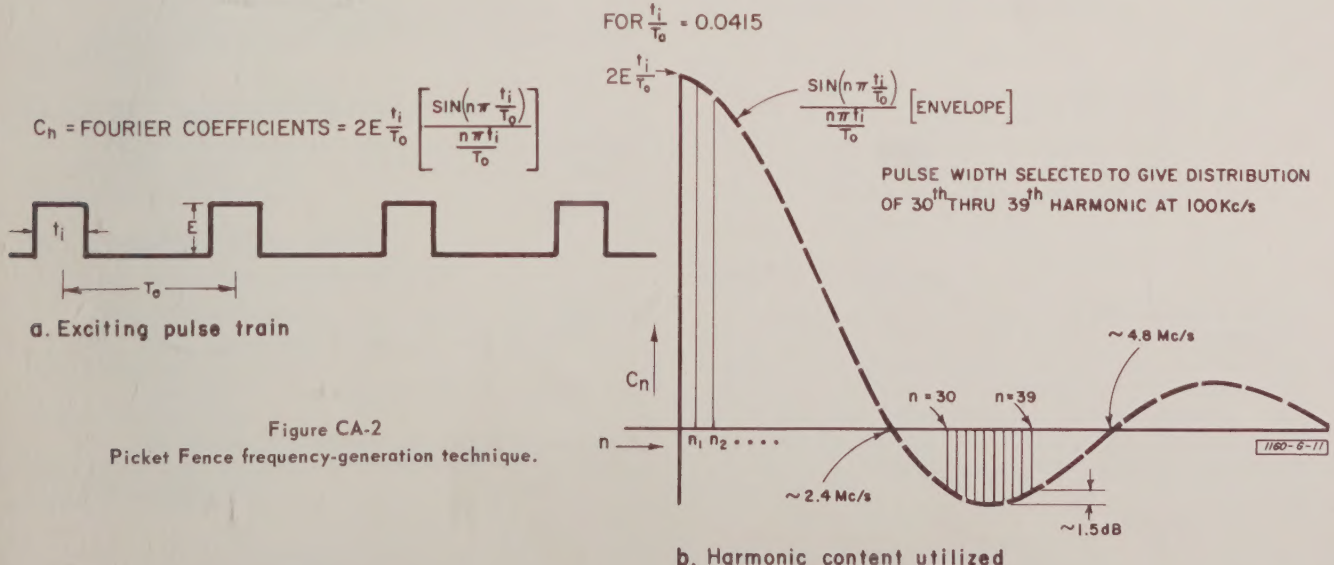


Figure CA-2
Picket Fence frequency-generation technique.

erator, the t_i/T_o duty ratio of the pulse is set to 0.0415, placing the first and second nulls of the $\frac{\sin x}{x}$ envelope at approximately 2.4 and 4.8 Mc/s, respectively. The pulse width is adjusted with C224, the time constant being determined primarily by C224, C225 and R241. When the pulse is adjusted to a width of 0.415 μs, the desired output band, 3.0 – 3.9 Mc/s, is centered in the second lobe of the response envelope, with the end pickets (3.0 and 3.9 Mc/s) drooping about 1.5 dB in amplitude below the center components.

The remaining selectivity in the Picket-Fence Section arises from two top-C coupled, tunable bandpass filters. The combined responses of these filters place two peaks near 3.0 and 3.9 Mc/s, with a 1.5-dB dip in the middle, to compensate for the peak in the output envelope of the pulse generator. The picket-fence circuit sequence is shown in Figure CA-9 to be the first filter T205/L204, followed by a buffer (Q213/Q214) with adjustable gain via R251. Then, a second filter, L205 and L206, is followed by a power-output stage that consists of an emitter-follower, Q215, a push-pull driver stage, Q216/Q217, and a push-pull output stage, Q218/Q219; all are transformer-coupled.

The balanced output goes to the PICKET-FENCE feed lines in the sandwich deck, via J203 and J205 into PL105 and PL106. J204, the center tap at the output transformer, is grounded in the sandwich deck via PL104.

CA-2.4 42-Mc SECTION (Figure CA-12).

The section of the AFS used to generate the 42-Mc signal is mounted on the small board (1160-0770/X). It is driven by the 1-Mc amplifier, Q203, mentioned previously in paragraph CA-2.3. The system consists of the following elements in order (see Figure CA-9). First, X7 transistor-multiplier, Q301, with 7-Mc tuned circuit L301, and a 7-Mc buffer with double-tuned, top-C coupled, bandpass filter, L302/L303. Next, a X3 multiplier produces 21 Mc/s, with T301 as the output tank followed by a 21-Mc buffer Q304/T302. A X2 multiplier, Q305/T303, multiplies the 21-Mc signal to 42 Mc/s and a 42-Mc output amplifier, Q306/T304, is the output stage.

SECTION CA-3

SERVICE AND MAINTENANCE

CA-3.1 GENERAL.

If the system trouble-analysis procedures of Section 5 at the front of the manual indicate possible malfunction of the AFS unit, the most positive verification of this suspicion is the substitution of another AFS module.

Since there is but one AFS module per instrument, and since service spares may not be available, it will not always be possible to make the substitution. However, selected tests, and most alignment procedures can be made in the field.

A thorough knowledge of the principles of the operation of this module is essential before service is attempted.

CA-3.2 TEST EQUIPMENT RECOMMENDED.

Table CA-2 lists the equipment recommended for service of the AFS modules. Equivalent equipment may be substituted.

CA-3.3 REMOVAL FROM CHASSIS.

CA-3.3.1 REMOVAL FROM CHASSIS.

Removal of the AFS is accomplished as follows:

a. Remove the synthesizer from the case; invert the instrument assembly.

b. Remove the two large screws that attach the AFS to the chassis.

c. Grasp the AFS module, by the GR874 connectors at the rear and the sheet metal grip at the front, and pull straight up.

CA-3.3.2 REMOVAL OF COVER.

Cover removal is accomplished as follows:

a. Remove the nine 4-40 screws in the bottom of the AFS, and the four from the top, to release the cover. The cover can then be slid forward, off the AFS unit.

b. Remount the open AFS on the Main Frame to provide loads and power for service and maintenance operation.

c. Reinstall the two large screws to hold the AFS down and make a positive ground-return connection between the AFS and the chassis.

NOTE

Electrical performance of the unit is not adversely affected by lack of the cover, except small signal leakages may degrade spurious performance of the synthesizer itself.

CA-3.3.3 REASSEMBLY.

Installation of the cover is the reverse of the above. Make sure that the cover, as it is installed, engages the spring fingers at the rear of the unit without interference. The cover goes between the lower lip of the rear panel and the contact fingers. The alignment tab on the left-hand end pan of the chassis will aid in the positioning of the AFS as it is installed in the chassis.

TABLE CA-2

TEST EQUIPMENT REQUIRED

Function	*Type Recommended*	*Minimal Characteristics*
Electronic Voltmeter (VTVM)	GR 1806-A	2% accuracy; ac and dc capabilities
Oscilloscope	Tektronix Model 543 (with C/A plug-in and P6006, 10 × passive probe)	20 Mc/s, 0.5 V/cm with 8 pF (or less) probe capacitance
Frequency Standard	GR 1115-B	5-Mc and 100-kc outputs, accurate to at least 1×10^{-6}
Termination (50-ohm)	GR 874-W50BL	0.5% accuracy and GR874 connector
Digital Frequency Meter	GR 1153-A	Dc to 10 Mc/s; 0.1 V sensitivity, p-to-p
Standard Sweep-Frequency Generator	GR 1025-A	0.5% calibration accuracy
Patch Cord	GR 874-R22LA	Coaxial with GR874 connectors
Tuned Voltmeter	Sufficient selectivity to separate picket-fence components, spaced 100-kc/s apart from 3.0 to 3.9 Mc/s. A communications receiver with metered i-f output can be used with a signal generator to substitute for the measured quantity, to establish the picket-fence component amplitude.	

CA-3.4 TROUBLE ANALYSIS

CA-3.4.1 GENERAL.

Malfunction within an AFS module, as indicated by the system trouble-analysis procedures found in Section 5 at the front of the manual, can be isolated further here. The indications obtained from external connectors and test points on the synthesizer can be used to localize the difficulty to a particular circuit. In the procedures that follow, the shield cover must be removed from the AFS unit to permit access to interior test and adjustment points (refer to paragraph CA-3.3).

In the performance of these tests the synthesizer Main Frame chassis is used to support the AFS unit, and the other modules are used to power it and to supply loads for its outputs. All modules or bridging units should be in place.

With the case removed from the synthesizer and the AFS unit installed (less shield cover), the instrument can be operated upside down on the test bench. The readings are the same whether or not the cover is in place.

CA-3.4.2 POWER-SUPPLY INPUTS.

Measure power-supply input voltages first. Two power-supply input connections are made to the AFS, via J105 and J202 of the AFS; these voltages should be +18 ±0.2 V dc. If they are not in this range, tests should be made elsewhere in the system to correct this problem (refer to Sections BA, BB, and GA).

CA-3.4.3 EXTERNAL STANDARD INPUT CIRCUITS.

NOTE

This circuitry is confined entirely to the AFS unit except for the front-panel control and monitor connections.

If the system does not lock, as indicated by the front-panel MONITOR meter, make sure that the free-running crystal-oscillator frequency is exactly 5 Mc/s, near the center of the range of the front-panel CRYSTAL FREQ control. Measure the frequency with the digital frequency meter connected to J108. If the frequency is not correct, set C122 so that 5 Mc/s occurs near the center of the CRYSTAL FREQ control range (refer to Table CA-5). If this does not clear up the difficulty, measure the dc voltage at J101, to determine that when R407, the CRYSTAL FREQ control is rotated, it affects the dc voltage at this point. Refer to Table CA-3 for the range of this adjustment. With no lock-signal input, the voltage at J103 should follow the CRYSTAL FREQ control and the voltage at J101.

When it has been determined that R407 is functioning normally, a 100-kc signal should be fed into the LOCK SIG IN JACK, J107, from the frequency

TABLE CA-3

OPERATING VOLTAGE SPECIFICATIONS
(See Figures CA-4 and CA-6)

INPUTS

Jack	*Description*	*Source Load*	*Measure With*	*Measured Level*	*Frequency*
J105	Power Supply No. 1 Input	Internal	Dc VTVM	+18 V +0.2 V with respect to ground.	—
J202	Power Supply No. 2 Input	Internal	Dc VTVM	+18 V ±0.2 V with respect to ground.	—
J101	Crystal Frequency Control	Internal	Dc VTVM	= +1.5 to +8.0 Vdc. Nominally +4 Vdc. Controlled from front panel of synthesizer.	—
J107 (Optional)	Lock-Signal Input	Frequency Standard	Ac VTVM	—	Any integral submultiple of 5 Mc/s − 100-kc/s to 5 Mc/s.

OUTPUTS

J108	5-Mc Output	874-W50BL	Ac VTVM	0.7-1.0 V, rms	5.00 Mc/s ±20 c/s
J206	100-kc Output	874-W50BL	Ac VTVM	0.5-1.0 V, rms	100 kc/s
J104	5 Mc/s to Mixer	Internal	Ac VTVM	0.3 V, rms, ±10%	5.00 Mc/s
J106	5 Mc/s to Digits	Internal	Ac VTVM	1.0 V, rms, ±10%	5.00 Mc/s
J201	1-Mc Output	Internal	Ac VTVM	0.7-1.0 V, rms	1.00 Mc/s
J205	Picket-Fence Output	Internal	Tuned Voltmeter	0.4 V, rms, per component — 3.0-3.8, +10, -15% 3.9, +10, -20%	30, 31, 32.....39th harmonic of 100.0 kc/s
J301	42-Mc Output	Internal	Ac VTVM	1.0 V, rms, ±10%	42.00 Mc/s
J103	Crystal-Lock Monitor Output	Internal	Dc VTVM	Same as J101 above with no signal at J107. Error voltage of phase detector when dc signal at J107 is present.	

Notes:
Voltages measured in a properly operating and loaded AFS unit with input voltages supplied by syntheisizer. The frequencies listed without tolerances are derived on a strict proportional basis from the 5-Mc standard. If an optional external standard is driving J107, the internal standard and all proportionally derived frequencies should be exactly proportional to the driving standard.

standard. Check the circuits from Q101 to Q108 with the procedures given in Table CA-5.

These checks should be sufficient to localize any malfunction in the multiplier to a single circuit. A check should also be made to ensure that a 5-Mc signal is being fed into the phase detector, through L110. If the circuit still fails to lock, check the line fed to the varactor CR104, through R125.

CA-3.4.4 5-Mc DISTRIBUTION CIRCUITS.

Several points in the system use a 5-Mc signal derived from different amplifiers in the AFS. These signals should be measured at various locations throughout the synthesizer to ascertain proper distribution. The 5-Mc signal should appear at J108 (rear of AFS), J151, the 5-Mc jack at rear of the chassis, and at the 5-Mc input to the CAD on the top of the deck (accessible when the CAD is removed). When the button under the CAD is depressed, the 5-Mc input signal to the CAD (PL213) is available at the "REF LINE" test point, TP103, on the left-hand end pan of the Main Frame chassis. It should be 300 mV, rms, ±10%, except J108 where it is 0.7 – 1.0 V, rms.

If any of these signals is absent, a check for shorts or opens in the system interconnecting wiring should be made (Section BA or BB). If no shorts or opens are present, the trouble lies in the AFS. The affected circuit can be found with the schematic diagrams and appropriate steps taken. The alignment procedure, Table CA-5, can be used as a guide.

CA-3.4.5 FREQUENCY DIVIDERS.

The three frequency dividers can be checked with oscilloscope Lissajous patterns. A 50:1 stationary pattern, formed between the 5-Mc (J108) and 100-kc (J206) outputs, on the rear apron of the AFS unit, should be obtained. If not, either the 1-Mc or 200-kc oscillator is not locked. If a Lissajous figure is set up between the 5-Mc and 1-Mc jacks at the rear of the sandwich deck (J152 in Types 1161, 1162, 1163 synthesizers) and a stationary 5:1 Lissajous is obtained, then the failure is in the 200-kc circuits. If the 5:1 pattern is not stationary, the 1-Mc oscillator is not locked. Similarly, a 10:1 Lissajous can be set up between 1-Mc and the 100-kc outputs. This will additionally check the 2-to-1 division by the flip-flop, Q207 and Q208. If any of these outputs is not present, check the stages involved (refer to Table CA-6).

If the 1-Mc signal is not present at the sandwich-deck receptacle, look for it at J201 on the AFS. It would be well also to make a continuity check of the chassis-jack circuits to make sure that a short or open circuit has not developed there (refer to Sections BA or BB).

CA-3.4.6 42-Mc CHECK.

The 42-Mc output feeding the DI-1 units and CAD is made available at the rear of the chassis (J155 for Types 1161, 1162 and 1163). This signal level can be measured with the electronic voltmeter.

If the signal is absent, check the 1-Mc signal at the rear of the sandwich (J152). If the 1-Mc signal is absent, the 1-Mc circuit should be restored to

(See Figure CA-6)

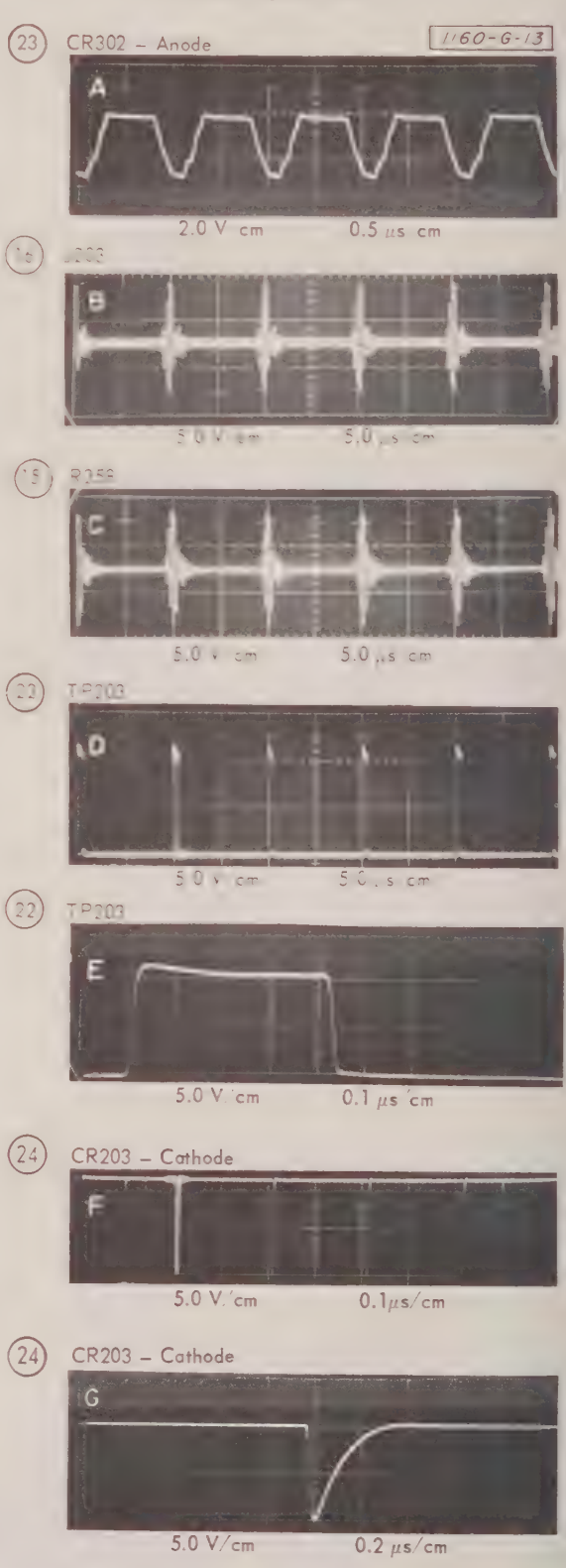


Figure CA-3. Trouble-analysis waveforms.

operation before further trouble analysis is attempted on the 42-Mc Section. If 1 Mc/s is present, check the waveform (Figure CA-3a) at the anode of CR302 to make sure that the X7 multiplier, Q301, is getting 1 Mc/s through the coaxial cable.

If the 42-Mc signal is absent, but the 1-Mc circuit appears to be operating properly, trouble analysis should center on the 42-Mc Section. This procedure can be done with reference to Table CA-7.

CA-3.4.7 PICKET-FENCE SECTION.

Operation of the Picket-Fence Section and distribution of its outputs can best be checked with an oscilloscope at the Main Frame test points labeled Picket Fence (TP101 in Type 1161/1162; TP101 and TP104 in Type 1163). They are mounted on the left-hand end pan of the chassis. The waveform here and at J205 on the AFS should be compared with Figure CA-3b for approximate shape and amplitude.

If the picket-fence signal is present, but indications in the system are that the Picket Fence Section is generating the wrong frequencies, check the dividers as in paragraph CA-3.4.5. If the picket-fence signal is absent completely, check for shorts in the Main Frame (Sections BA/BB) or in an individual DI-1 unit.

If the Picket-Fence Section supply busses are not shorted in the chassis, or in a DI-1 unit, the difficulty is in the AFS. The 100-kc output (J206) should be measured next (Table CA-3). If this output is absent, the trouble may be in the flip-flop divider Q207/Q208, or in the other dividers.

If the 100-kc signal is operative, check the pulse waveforms at Q211/Q212 (TP203) and then follow along the signal-flow path until the defective circuit is found (see Figure CA-3c-g). Refer to Table CA-6 for alignment details.

CAUTION

Normally, C224, R251 and the bandpass-filter tuning adjustments T205, L204, L205 and L206 should not be disturbed.

CA-3.5 ALIGNMENT PROCEDURES.

If the trouble-analysis procedures of paragraph CA-3.4 indicate marginal performance of a circuit function, or if repairs or replacements have been made, realignment of the many tuned circuits in the AFS unit may be required; Table CA-4 lists special tools recommended. Material in Tables CA-5 through CA-7 presents the alignment procedures. Typical waveforms to be looked for appear in Figures CA-5, CA-7, and CA-8. Figures CA-4 and CA-6 show test points and secondary-adjustment controls.

CA-3.6 REPAIRS AND REPLACEMENTS.

If subnormal circuits don't respond to adjustments indicated in the alignment procedures, use the schematic diagrams of Figures CA-10 through CA-12 to localize the trouble area and replace defective detail parts. The parts list at the end of this section gives pertinent descriptive information on parts used and reference designators appearing there are the same as those used on schematics and photos. In most cases, the designators are silk-screened on the etched-circuit board to complete the identification.

As an aid to isolate the defective part, Table CA-8 lists dc voltages at transistor leads in all stages of a properly functioning AFS unit. Basing diagrams for the transistor types used are given on the schematic diagrams. The collector lead is identified by a dot on the foil side of the etched-circuit boards.

TABLE CA-4

ALIGNMENT TOOLS RECOMMENDED

Type Adjustment	*Recommended Tool*
Ferrite cup-core inductors and transformers or Potentiometers	Any suitable screwdriver fitting the screw slot, or JFD #5284.
Ceramic Capacitors	Insulated screwdriver with minimum metallic contact with screw slot, e.g. JFD #5284.
Internally threaded ceramic coil with threaded, powdered-iron slug	Insulated soft-tip screwdriver. JFD #5284 may be used if care is taken not to damage brittle powdered iron.

NOTE: JFD = JFD Electronics Corporation, Brooklyn, New York.

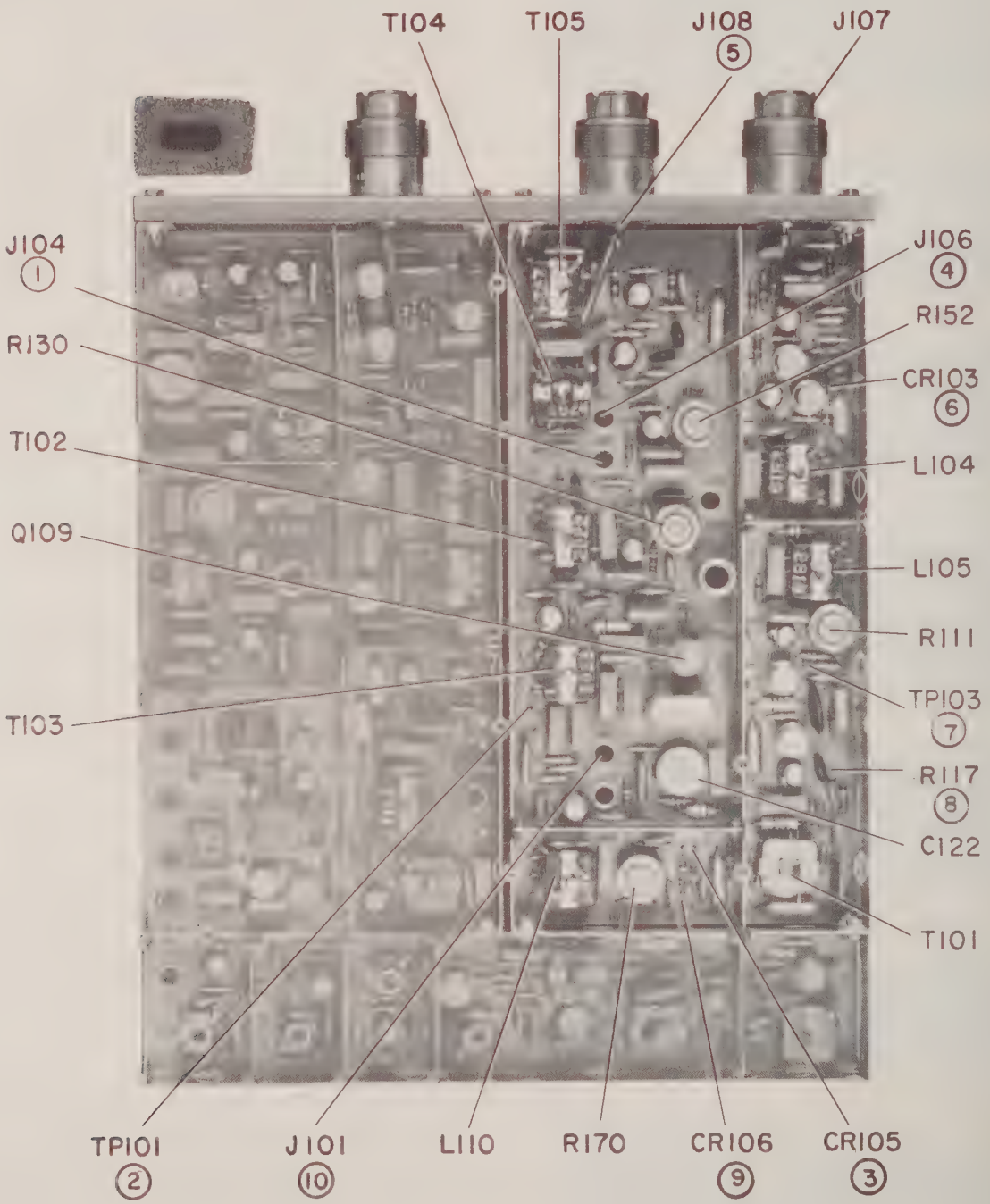


Figure CA-4.
Master Frequency Section – test points and alignment controls.

TABLE CA-5

CIRCUIT ALIGNMENT CHECK CHART
MASTER FREQUENCY SECTION (Figures CA-4 and CA-5).

Circuit	*Test Point*	*Instrument*	*Alignment Procedures*
5-Mc buffer tuning	J104 (1)	V	Adjust T102 for maximum 5 Mc/s.
5-Mc output	J104 (1)	V	Adjust R130 for 300 m V, rms.
5-Mc amplifier tuning	TP101 (2)	O	Adjust T103 for maximum at 5 Mc/s.
5-Mc amplifier tuning	CR105 (Anode) (3)	O	Adjust L110 for maximum at 5 Mc/s.
5-Mc amplifier tuning	J106 (4)	V	Adjust T104 for maximum 5 Mc/s.
5-Mc amplifier tuning	J106 (4)	V	Adjust R152 for 1 V, rms, 5 Mc/s.
5-Mc ext output tuning	J108 (5)	V	Adjust T105 for maximum 5-Mc sine wave.
Input Schmitt-trigger	CR103 (Cathode) (6)	O	Remove Q109 (stops crystal oscillator). Inject standard 100-kc, 0.2-5.0 V, rms, signal at J107 and observe waveform, Fig. CA-5 (a). Inject standard 5-Mc, 0.2-5.0 V, rms, signal at J107 and observe waveform of Fig. CA-5 (b).
5-Mc bandpass filter	TP103 (7)	O	Retain 5-Mc input at J107 and adjust L104 and L105 for maximum at 5 Mc/s; Fig. CA-5 (c). Reinject 100 kc/s at J107; slightly retouch L104 and L105 for minimum envelope dip, as in Figure CA-5 (d).
Schmitt-trigger trip point	R117/Q107 (8)	O	Adjust R111 for continuous triggering with 100 kc/s at J107; see Figure CA-5 (f).
5-Mc drive to phase detector (reference side)	CR106 (Anode) (9)	O	Adjust T101 for maximum 5 Mc/s with 100 kc/s or 5 Mc/s at J107.
Phase-detector balance	Front-panel MONITOR meter	—	Reinsert Q109. Remove standard signals. Adjust R170 to center meter with S411 (front-panel) in LOCK TO EXT STD position.
Coarse CRYSTAL FREQ trim	J101 (10)	V	Adjust CRYSTAL FREQ (R407 front-panel control) to read 4 V dc.
	J108	C	Adjust C122 for 5.0 Mc/s ±5 c/s with non-metallic screwdriver.
Phase lock	Front-panel MONITOR meter	—	Inject standard 5 Mc/s, 0.2-5.0 V, rms, signal at J107. Slowly turn CRYSTAL FREQ control (R407 on front panel) back and forth and observe that meter follows this movement smoothly, to confirm that internal oscillator is locked to external standard. Repeat at 100 kc/s.

NOTES: The loop formed in the part lead serves as the test point. Instrument: O = Oscilloscope; V = VTVM; C = Counter. Probes required.

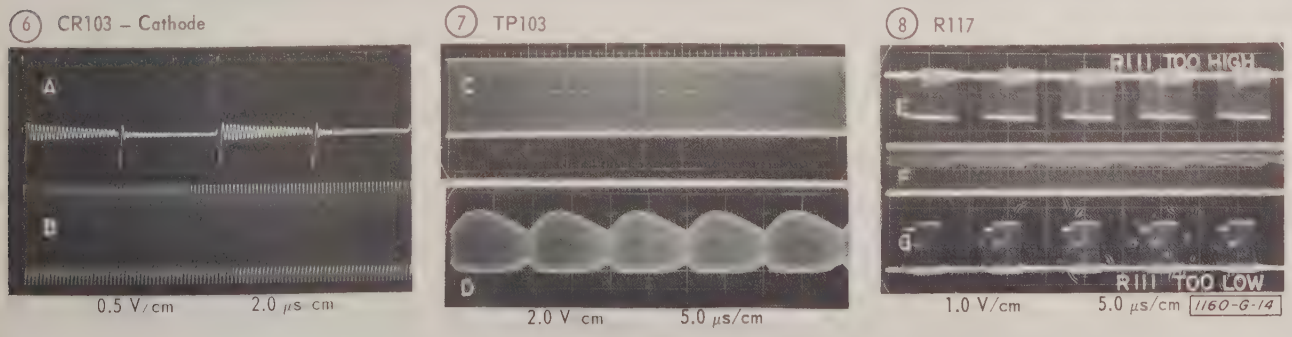


Figure CA-5. Master Frequency Section alignment waveforms.

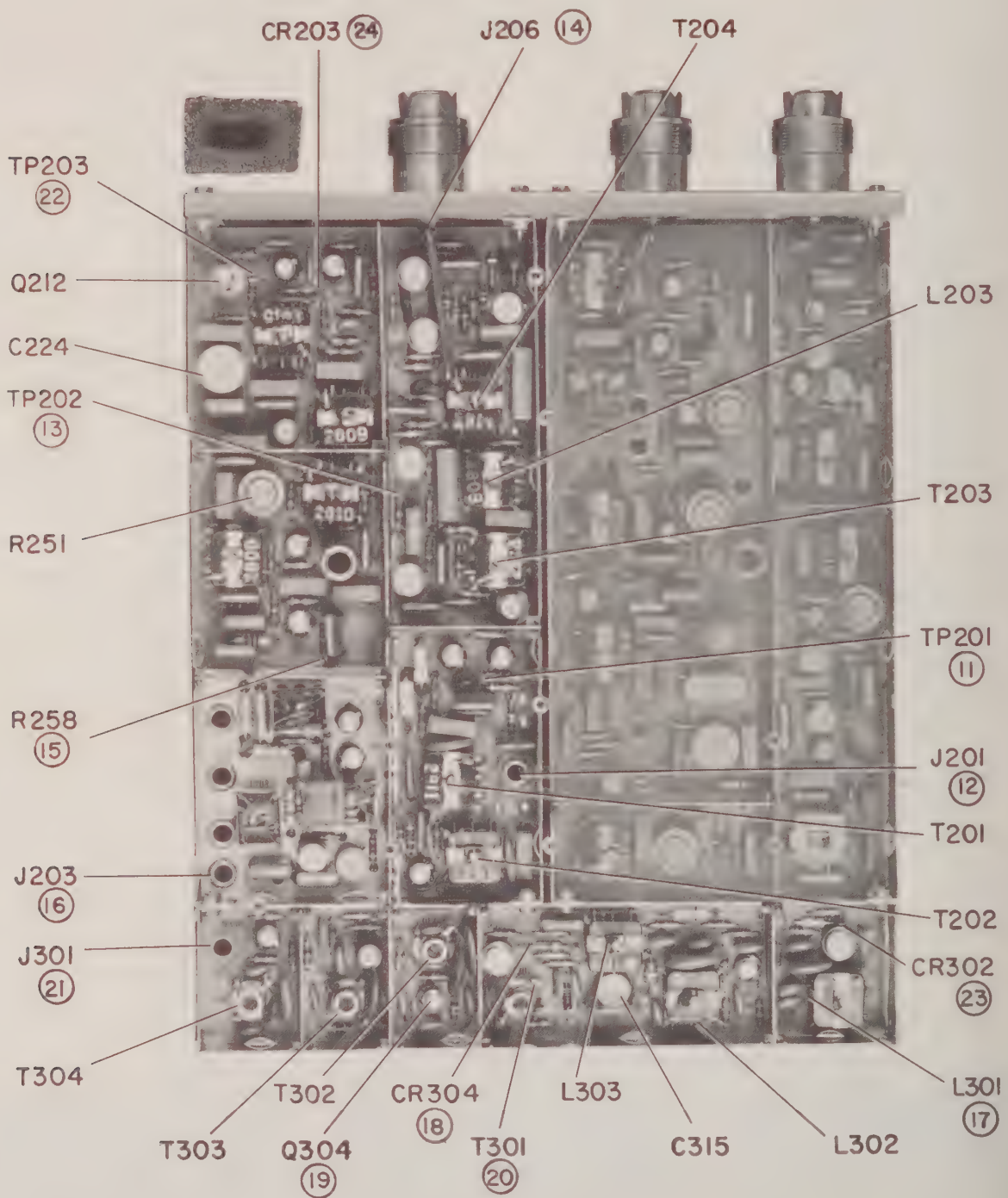


Figure CA-6.
Picket Fence and 42-MC Sections – test points and alignment controls.

TABLE CA-6

CIRCUIT ALIGNMENT CHECK CHART
PICKET FENCE SECTION (Figures CA-6 and CA-7)

Circuit	*Test Point*	*Instrument*	*Alignment Procedures*
1-Mc oscillator tuning	TP201 (11)	O	Adjust T201 for lock; waveforms in Figure CA-7 (a and b).
1-Mc amplifier tuning	J201 (12)	V	Adjust T202 for maximum at 1 Mc/s
1-Mc buffer tuning	TP202 (13)	O	Adjust T203 for maximum at 1 Mc/s; see Figure CA-7 (c and d).
200-kc oscillator tuning	TP202 (13)	O	Adjust L203 for lock; waveforms in Figure CA-7 (c and d).
100-kc ext. output	J206 (14)	V	Adjust T204 for maximum at 100 kc/s
Bandpass filters (3.0-3.9 Mc)	(either end of R258) (15)	O	Remove Q212. Drive C-terminal Q212 (TP203). Sweep 2.4—4.8-Mc range. Swept response as in Figure CA-7 (e).
Picket-Fence level symmetry	J203, J205 (16)	T	Reinstall Q212. Adjust picket fence per Table CA-3. C224 tilts picket fence; R251 adjusts over-all levels.

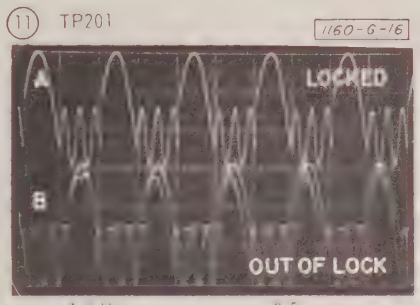
TABLE CA-7

CIRCUIT ALIGNMENT CHECK CHART
42-MC SECTION (Figures CA-6 and CA-8)

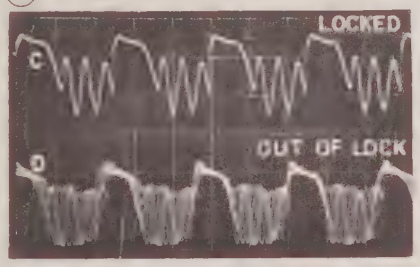
Circuit	*Test Point*	*Instrument*	*Alignment Procedures*
7-Mc multiplier tuning	L301, pin 2 (17)	O	Adjust L301 for maximum at 7 Mc/s, Figure CA-8 (a).
7-Mc amplifier bandpass-filter tuning	Anode CR304 (18)	O	Adjust L302/L303 for largest amplitude, Figure CA-8 (b).
21-Mc multiplier drive	Q304 (case) (19)	O	Adjust C315 for 5 V, peak.
21-Mc multiplier tuning	T301, pin 3 (20)	O	Adjust T301 for maximum at 21 Mc/s. Reset if necessary; see Fig. CA-8 (c).
21-Mc amplifier tuning	J301 (21)	V	Tune T302 for maximum at 42 Mc/s.
42-Mc multiplier tuning	J301 (21)	V	Tune T303 for maximum at 42 Mc/s.
42-Mc amplifier tuning	J301 (21)	V	Tune T304 for maximum at 42 Mc/s.

NOTES: Loop in part lead forms test points. Probes required.
Instrument: O =Oscilloscope, V =VTVM, T =Tuned Voltmeter.

(11) TP201



(13) TP202



(15) R258

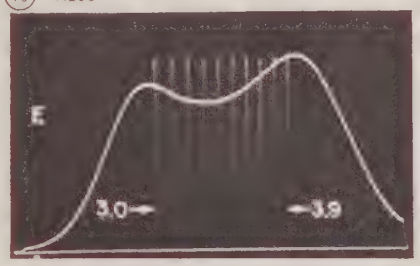
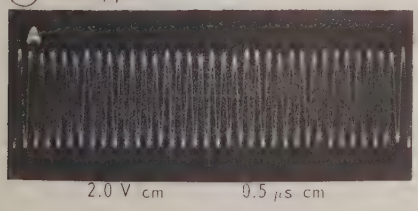
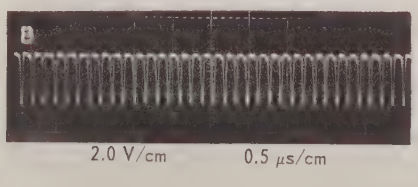


Figure CA-7.
Picket Fence Section alignment waveforms.

(17) L301, pin 2



(18) CR304 — Anode



(20) T301, pin 3

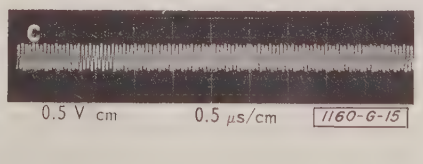


Figure CA-8.
42-Mc Section alignment waveforms.

TABLE CA-8

DC VOLTAGES – AFS-1

Transistor	*Emitter*	*Base*	*Collector*
Q101	4.5	3.8	2.0
Q102	2-2.5	2.0	1.0-1.5
Q103	2-2.5	2-2.5	0
Q104	0	0	17.5
Q105	2.0	2-3	17.5
Q106	2-2.5	2.0	1.0-1.5
Q107	2-2.5	2-2.5	0-1.2
Q108	9	9.7	17.5
Q109	1.3	1.05	0
Q110	8.8	9.5	17.5
Q111	13.4	13.5	0
Q112	12.7	15.5	0
Q113	8.4	8.5	17.5
Q114	8.0	8.8	17.0
Q115	8.0	8.8	17.0
Q201	11.0	10.5	15.0
Q202	11.0	10.5	15.0
Q203	4.0	4.6	15.5
Q204	15.0	15.1	0
Q205	12.0	12.1	16.0
Q206	12.0	12.1	15.0
Q207	13.8	14.5	7.5
Q208	13.8	14.5	7.5
Q209	1.7	1.8	17.5
Q210	0.05	–	16.0
Q211	4.6	4.5	16.0
Q212	4.6	6.0	6.0
Q213	4.4	4.1	0
Q214	3.7	4.4	17.0
Q215	8.2	8.8	17.5
Q216	0.1	–	17.8
Q217	0.1	–	17.8
Q218	0.1	–	17.8
Q219	0.1	–	17.8
Q301	6.5	7.0	0
Q302	11.2	12.5	17
Q303	6.8	7.0	0
Q304	7.5	8.1	17
Q305	8.3	8.3	0
Q306	9.0	9.7	17

NOTES:
1. AFS plugged into fully equipped Type 1163-A7C.
2. No input lock signal and no loads on 5-Mc and 100-kc outputs.
3. All measurements made with Type 1806-A (direct-no probe).
4. Allow ±10% tolerance for all readings.

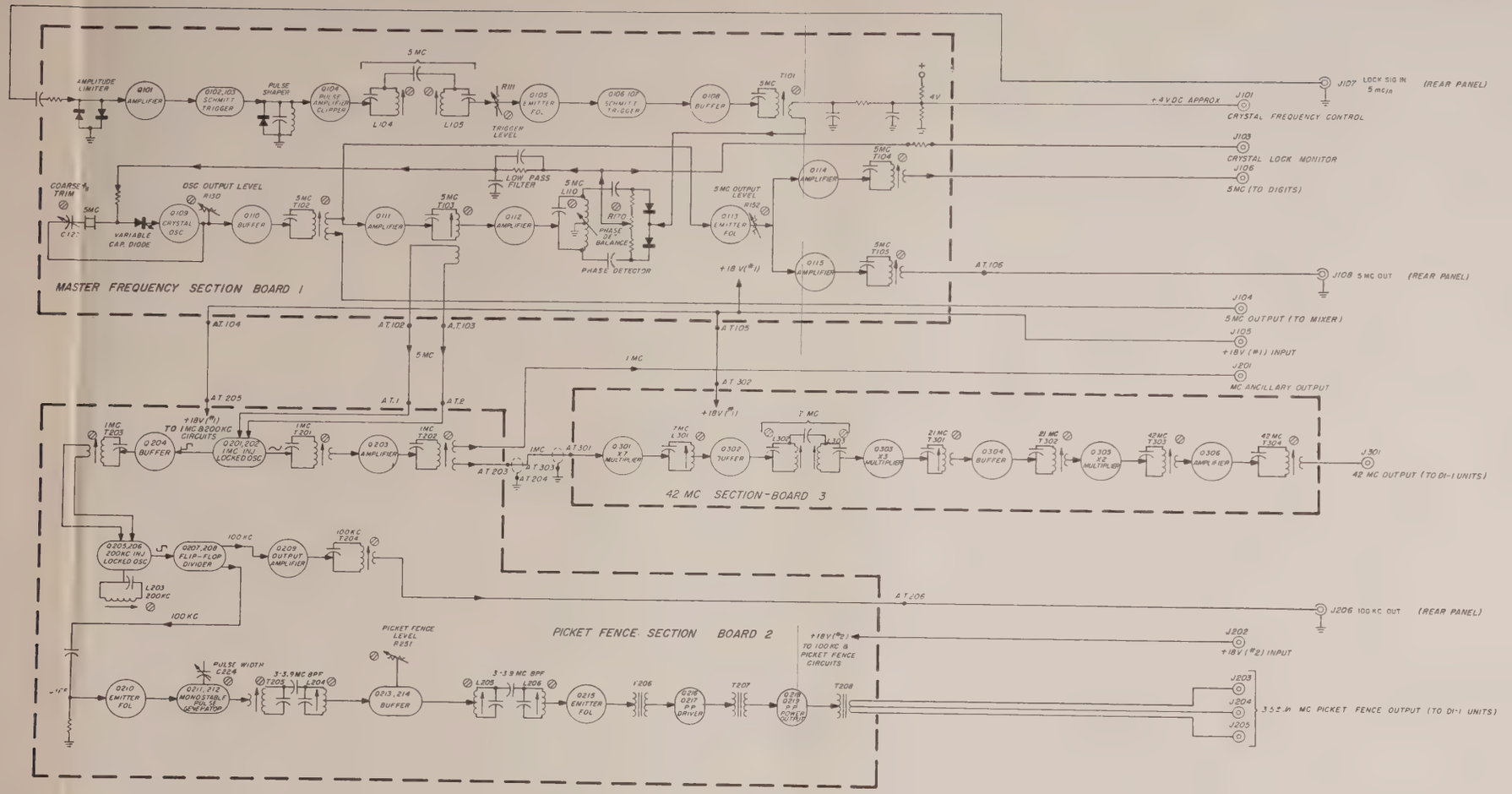
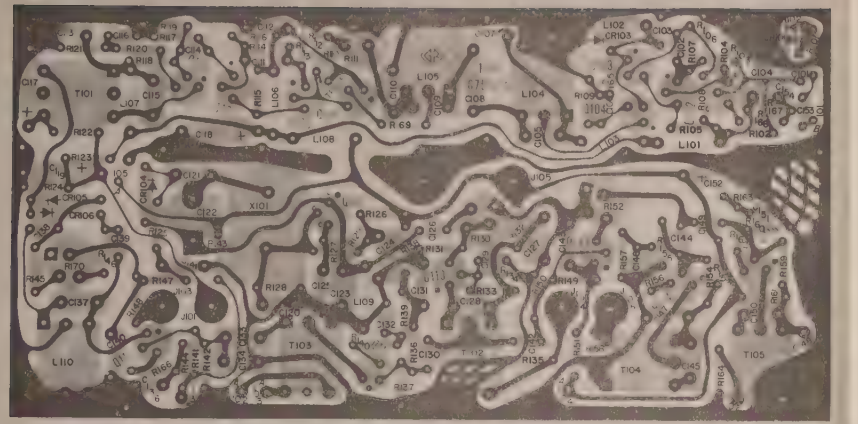


Figure CA-9.
Elementary schematic diagram for Ancillary Frequency Source – AFS-1.



Master Frequency Circuit etched-board assembly (P/N 1160-2750).

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

PARTS LIST

REF NO	DESCRIPTION	PART NO
	CAPACITORS	
C101	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C102	Ceramic, 33 pF ±5% 500 V (N750)	4417-0335
C103	Ceramic, 220 pF ±10% 500 V	4404-1228
C104	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C105	Mica, 90.9 pF ±2% 500 V	4700-0390
C106	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C107	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C108	Ceramic, 1 pF ±10% 500 V	4400-0100
C109	Mica, 90.9 pF ±2% 500 V	4700-0390
C110	Ceramic, 1 µF ±20% 25 V	4400-2070
C111	Ceramic, 33 pF ±5% 500 V (NPO)	4410-0335
C112	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C113	Ceramic, 0.1 µF ±20% 25 V	4400-2050
C114	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C115	Mica, 180 pF ±5% 500 V	4700-0650
C116	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C117	Electrolytic, 33 µF ±20% 10 V	4450-5400
C118	Electrolytic, 15 µF ±20% 20 V	4450-5200
C119	Electrolytic, 33 µF ±20% 10 V	4450-5400
C120	Mica, 0.0015 µF ±5% 100 V	4700-0690
C121	Mica, 27.4 pF ±2% 500 V	4700-0236
C122	Trimmer, 5 to 25 pF	4910-1150
C123	Mica, 120 pF ±5% 500 V	4700-0426
C124	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C125	Ceramic, 1 µF ±20% 25 V	4400-2070
C126	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C127	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C128	Mica, 62 pF ±5% 500 V	4700-0364
C129	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C130	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C131	Ceramic, 1 µF ±20% 25 V	4400-2070
C132	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C133	Mica, 180 pF ±5% 500 V	4700-0650
C134	Mica, 200 pF ±5% 500 V	4700-0507
C135	Ceramic, 1 µF ±20% 25 V	4400-2070
C136	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C137	Mica, 180 pF ±5% 500 V	4700-0650
C138	Ceramic, 22 pF ±5% 500 V (NPO)	4410-0225
C139	Ceramic, 22 pF ±5% 500 V (NPO)	4410-0225
C140	Ceramic, 0.22 µF ±20% 25 V	4400-2052
C141	Ceramic, 0.47 µF ±20% 25 V	4400-2054
C142	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C143	Ceramic, 1 µF ±20% 25 V	4400-2070
C144	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C145	Mica, 180 pF ±5% 500 V	4700-0650
C146	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C147	Ceramic, 0.1 µF ±20% 25 V	4400-2050
C148	Ceramic, 0.1 µF ±20% 25 V	4400-2050
C149	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C150	Mica, 180 pF ±5% 500 V	4700-0650
C151	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C152	Electrolytic, 15 µF ±20% 20 V	4450-5200
C153	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C154	Ceramic, 0.22 µF ±20% 25 V	4400-2052
C201	Ceramic, 0.22 µF ±20% 25 V	4400-2052
C202	Ceramic, 39 pF ±10% 500 V	4700-0307
C203	Ceramic, 1 µF ±20% 25 V	4400-2070
C204	Mica, 681 pF ±1% 300 V	4710-0681
C205	Ceramic, 0.1 µF ±20% 25 V	4400-2050
C206	Ceramic, 0.1 µF ±20% 25 V	4400-2050
C207	Mica, 562 pF ±1% 300 V	4710-0629
C208	Mica, 150 pF ±5% 500 V	4700-0441
C209	Ceramic, 0.1 µF ±20% 25 V	4400-2050

REF NO	DESCRIPTION	PART NO
	CAPACITORS (Cont)	
C210	Ceramic, 1 µF ±20% 25 V	4400-2070
C211	Mica, 0.0036 µF ±5% 300 V	4580-3600
C212	Mica, 120 pF ±10% 500 V	4700-0425
C213	Ceramic, 1 µF ±20% 25 V	4400-2070
C214	Ceramic, 100 pF ±10% 500 V	4404-1108
C215	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C216	Ceramic, 100 pF ±10% 500 V	4404-1108
C217	Ceramic, 100 pF ±10% 500 V	4404-1108
C218	Ceramic, 0.47 µF ±20% 25 V	4400-2054
C219	Ceramic, 1 µF ±20% 25 V	4400-2070
C220	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C221	Mica, 0.0036 µF ±5% 300 V	4580-3600
C222	Ceramic, 15 pF ±5% 500 V (N750)	4417-0155
C223	Ceramic, 1 µF ±20% 25 V	4400-2070
C224	Trimmer, 5 to 25 pF	4910-1150
C225	Mica, 121 pF ±1% 500 V	4710-0031
C226	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C227	Mica, 36.5 pF ±2% 500 V	4700-0304
C228	Mica, 27.4 pF ±2% 500 V	4700-0236
C229	Mica, 36.5 pF ±2% 500 V	4700-0304
C230	Ceramic, 1 µF ±20% 25 V	4400-2070
C231	Ceramic, 1 µF ±20% 25 V	4400-2070
C232	Ceramic, 1 µF ±20% 25 V	4400-2070
C233	Mica, 27.4 pF ±2% 500 V	4700-0236
C234	Mica, 36.5 pF ±2% 500 V	4700-0304
C235	Mica, 33.2 pF ±2% 500 V	4700-0670
C236	Ceramic, 1 µF ±20% 25 V	4400-2070
C237	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C238	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C239	Ceramic, 1 µF ±20% 25 V	4400-2070
C240	Ceramic, 1 µF ±20% 25 V	4400-2070
C241	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C242	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C243	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C244	Electrolytic, 15 µF ±20% 20 V	4450-5200
C245	Ceramic, 120 pF ±5% 500 V (N750)	4417-1125
C246	Ceramic, 150 pF ±5% 500 V (N750)	4417-1155
C301	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C302	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479
C303	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C304	Ceramic, 15 pF ±5% 500 V (N750)	4417-0155
C305	Ceramic, 75 pF ±5% 500 V (N30)	4411-0753
C306	Ceramic, 22 pF ±5% 500 V (N750)	4417-0225
C307	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C308	Ceramic, 20 pF ±5% 500 V (N750)	4417-0205
C309	Ceramic, 100 pF ±5% 500 V (N30)	4411-1105
C310	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C311	Ceramic, 1.2 µF ±10% 500 V	4400-0129
C312	Ceramic, 20 pF ±5% 500 V (N750)	4417-0205
C313	Ceramic, 100 pF ±5% 500 V (N30)	4411-1105
C314	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C315	Trimmer, 2 to 8 pF 350 V	4910-2045
C316	Ceramic, 62 pF ±5% 500 V (N30)	4411-0625
C317	Ceramic, 15 pF ±5% 500 V (N30)	4411-0155
C318	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C319	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479
C320	Ceramic, 0.01 µF +80-20% 50 V	4401-3100
C321	Ceramic, 91 pF ±5% 500 V (N30)	4411-0915
C322	Ceramic, 56 pF ±5% 500 V (N30)	4411-0565
C323	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479
C324	Ceramic, 47 pF ±5% 500 V (N30)	4411-0475
C325	Ceramic, 22 pF ±5% 500 V (N30)	4411-0225
C326	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479

PARTS LIST (Cont)

REF NO	DESCRIPTION	PART NO
	CAPACITORS (Cont)	
C327	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479
C328	Ceramic, 0.0022 µF +80-20% 500 V	4404-2229
C329	Ceramic, 0.0022 µF +80-20% 500 V	4404-2229
C330	Ceramic, 0.0022 µF +80-20% 500 V	4404-2229
C331	Ceramic, 68 pF ±5% 500 V (N30)	4411-0685
C332	Ceramic, 15 pF ±5% 500 V (N30)	4411-0155
C333	Ceramic, 2.2 µF ±20% 25 V	4400-2080
	DIODES	
CR101	Semiconductor, type 1N3604	6082-1001
CR102	Semiconductor, type 1N3604	6082-1001
CR103	Semiconductor, type 1N995	6082-1002
CR104	Semiconductor, type 1N953	6084-1006
CR105	Semiconductor, type 1N191	6082-1008
CR106	Semiconductor, type 1N191	6082-1008
CR201	Semiconductor, type 1N118A	6082-1006
CR202	Semiconductor, type 1N118A	6082-1006
CR203	Semiconductor, type 1N3604	6082-1001
CR204	Semiconductor, type 1N3604	6082-1001
CR301	Semiconductor, type 1N957A	6083-1008
CR302	Semiconductor, type 1N995	6082-1002
CR303	Semiconductor, type 1N957A	6083-1008
CR304	Semiconductor, type 1N995	6082-1002
	INDUCTORS	
L101	Choke, iron core 22 µH ±10%	4300-2600
L102	Choke, iron core 4.7 µH ±10%	4300-1600
L103	Choke, iron core 22 µH ±10%	4300-2600
L104	Adjustable, ferrite cup	5000-2819
L105	Adjustable, ferrite cup	5000-2819
L106	Choke, iron core 22 µH ±10%	4300-2600
L107	Choke, iron core 22 µH ±10%	4300-2600
L108	Choke, iron core 22 µH ±10%	4300-2600
L109	Choke, iron core 22 µH ±10%	5000-2820
L110	Adjustable, ferrite cup	5000-2820
L201	Choke, iron core 33,000 µH ±5%	4300-6398
L202	Choke, iron core 33,000 µH ±5%	4300-6398
L203	Adjustable, ferrite cup	5000-2808
L204	Adjustable, ferrite cup	5000-2809
L205	Adjustable, ferrite cup	5000-2810
L206	Adjustable, ferrite cup	5000-2809
L207	Choke, iron core, 10 µH ±10%	4300-2200
L208	Choke, iron core, 5.6 µH ±10%	4300-1800
L209	Choke, iron core, 5.6 µH ±10%	4300-1800
L210	Choke, iron core, 5.6 µH ±10%	4300-1800
L301	Adjustable, ferrite cup	5000-2807
L302	Adjustable, ferrite cup	5000-2806
L303	Adjustable, ferrite cup	5000-2806
L304	Choke, iron core, 22 µH ±10%	5000-2820
	JACKS	
J101	Etched-circuit, eyelet type	1160-6110
J103	Etched-circuit, eyelet type	1160-6110
J104	Etched-circuit, eyelet type	1160-6110
J105	Etched-circuit, eyelet type	1160-6110
J106	Etched-circuit, eyelet type	1160-6110
J107	GR874, coaxial, panel, lug	0874-4260
J108	GR874, coaxial, panel, lug	0874-4260
J201	Etched-circuit, eyelet type	1160-6110
J202	Etched-circuit, eyelet type	1160-6110
J203	Etched-circuit, eyelet type	1160-6110
J204	Etched-circuit, eyelet type	1160-6110
J205	Etched-circuit, eyelet type	1160-6110
J206	GR874, coaxial, panel, lug	0874-4260
J301	Etched-circuit, eyelet type	1160-6110

REF NO	DESCRIPTION	PART NO
	RESISTORS	
R101	Composition, 47Ω ±5% 1/4 W	6099-0475
R102	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R103	Composition, 1.2 kΩ ±5% 1/4 W	6099-2125
R104	Composition, 330Ω ±5% 1/4 W	6099-1335
R105	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R106	Composition, 100Ω ±5% 1/4 W	6099-1105
R107	Composition, 330Ω ±5% 1/4 W	6099-1335
R108	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R109	Composition, 100Ω ±5% 1/4 W	6099-1105
R110	Composition, 12 kΩ ±5% 1/4 W	6099-3125
R111	Potentiometer, composition, 2.5kΩ ±20% 1/4 W	6040-0500
R112	Composition, 330Ω ±5% 1/4 W	6099-1335
R113	Composition, 100Ω ±5% 1/4 W	6099-1105
R114	Composition, 330Ω ±5% 1/4 W	6099-1335
R115	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R116	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R117	Composition, 100Ω ±5% 1/4 W	6099-1105
R118	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825
R119	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R120	Composition, 100Ω ±5% 1/4 W	6099-1105
R121	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225
R122	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R123	Composition, 120 kΩ ±5% 1/4 W	6099-4125
R124	Composition, 33 kΩ ±5% 1/4 W	6099-3335
R125	Composition, 68 kΩ ±5% 1/4 W	6099-3685
R126	Composition, 470Ω ±5% 1/4 W	6099-1475
R127	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R128	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R129	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R130	Potentiometer, composition, 5 kΩ ±20%	6040-0600
R131	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395
R132	Composition, 100Ω ±5% 1/4 W	6099-1105
R133	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R134	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R135	Composition, 100Ω ±5% 1/4 W	6099-1105
R136	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R137	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R138	Composition, 150Ω ±5% 1/4 W	6099-1155
R139	Composition, 680Ω ±5% 1/4 W	6099-1685
R140	Composition, 820Ω ±5% 1/4 W	6099-1825
R141	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R142	Composition, 33 kΩ ±5% 1/4 W	6099-3335
R143	Composition, 150Ω ±5% 1/4 W	6099-1155
R144	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R145	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R146	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R147	Composition, 22 kΩ ±5% 1/4 W	6099-3225
R148	Composition, 39 kΩ ±5% 1/4 W	6099-3395
R149	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R150	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R151	Composition, 100Ω ±5% 1/4 W	6099-1105
R152	Potentiometer, composition, 2.5 kΩ ±20%	6040-0500
R153	Composition, 47Ω ±5% 1/4 W	6099-0475
R154	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R155	Composition, 12 kΩ ±5% 1/4 W	6099-3125
R156	Composition, 33Ω ±5% 1/4 W	6099-0335
R157	Composition, 560Ω ±5% 1/4 W	6099-1565
R158	Composition, 51Ω ±5% 1/4 W	6099-0515
R159	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R160	Composition, 12 kΩ ±5% 1/4 W	6099-3125
R161	Composition, 47Ω ±5% 1/4 W	6099-0475
R162	Composition, 33Ω ±5% 1/4 W	6099-0335
R163	Composition, 560Ω ±5% 1/4 W	6099-1565
R164	Composition, 51Ω ±5% 1/4 W	6099-0515
R165	Composition, 390Ω ±5% 1/4 W	6099-1395
R166	Composition, 390Ω ±5% 1/4 W	6099-1395

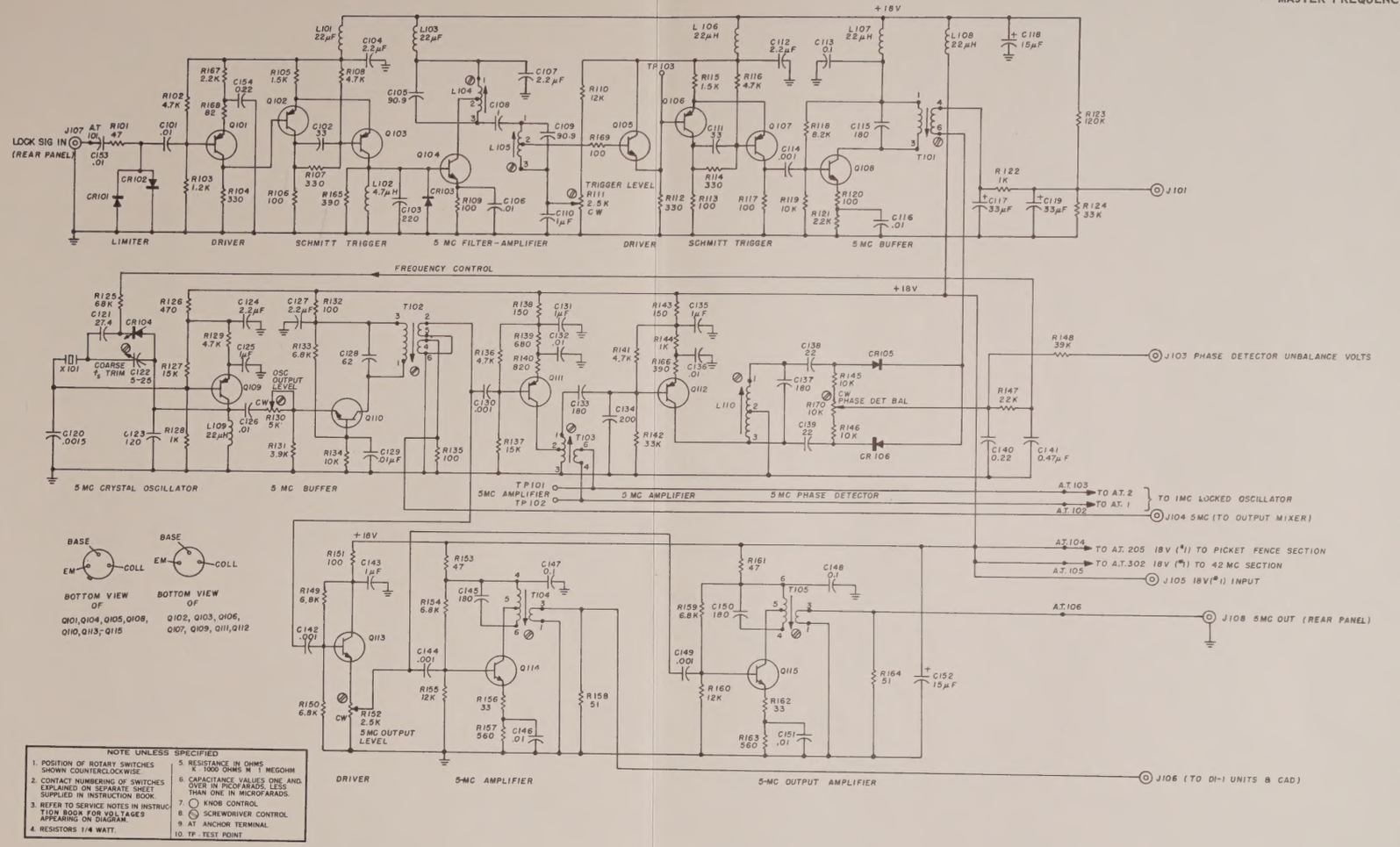
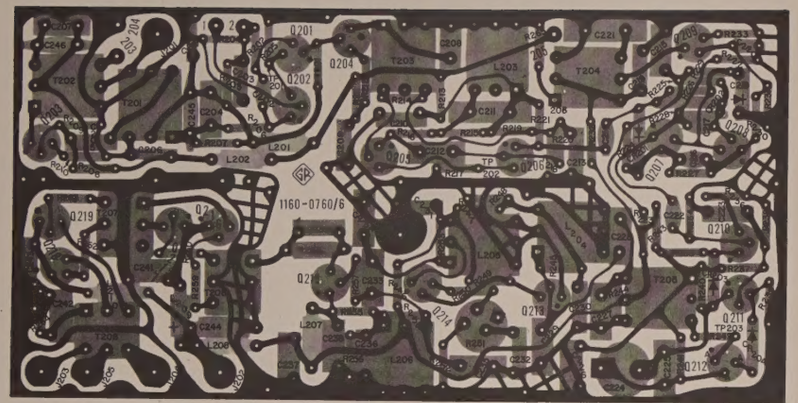

LOCK SIG IN (REAR PANEL)
LIMITER
DRIVER
SCHMITT TRIGGER
5 MC FILTER-AMPLIFIER
DRIVER
SCHMITT TRIGGER
5 MC BUFFER
FREQUENCY CONTROL
5 MC CRYSTAL OSCILLATOR
5 MC BUFFER
5 MC AMPLIFIER
5 MC AMPLIFIER
5 MC PHASE DETECTOR
TO IMC LOCKED OSCILLATOR
J104 5MC (TO OUTPUT MIXER)
J103 PHASE DETECTOR UNBALANCE VOLTS
J101
J105 18V(*1) INPUT
J108 5MC OUT (REAR PANEL)
J106 (TO DI-1 UNITS & CAD)
DRIVER
5-MC AMPLIFIER
5-MC OUTPUT AMPLIFIER
BOTTOM VIEW OF Q101,Q104,Q105,Q108, Q110,Q113,Q115
BOTTOM VIEW OF Q102, Q103, Q106, Q107, Q109, Q111,Q112
NOTE UNLESS SPECIFIED
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS. LESS THAN ONE IN MICROFARADS.
7. KNOB CONTROL.
8. SCREWDRIVER CONTROL.
9. AT ANCHOR TERMINAL.
10. TP - TEST POINT

Figure CA-10.
Schematic diagram for Master Frequency Section.



Picket Fence Circuit etched-board assembly (P/N 1160-2761).

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

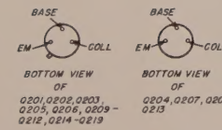
PARTS LIST (Cont)

REF NO	DESCRIPTION	PART NO
	RESISTORS (Cont)	
R167	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225
R168	Composition, 82Ω ±5% 1/4 W	6099-0825
R169	Composition, 100Ω ±5% 1/4 W	6099-1105
R170	Potentiometer, composition, 10 kΩ ±20%	6040-0700
R201	Composition, 270Ω ±5% 1/4 W	6099-1275
R202	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R203	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565
R204	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R205	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R206	Composition, 270Ω ±5% 1/4 W	6099-1275
R207	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R208	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R209	Composition, 680 kΩ ±5% 1/4 W	6099-1680
R210	Composition, 470Ω ±5% 1/4 W	6099-1475
R211	Composition, 220Ω ±5% 1/4 W	6099-1225
R212	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R213	Composition, 47Ω ±5% 1/4 W	6099-0475
R214	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R215	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R216	Composition, 270Ω ±5% 1/4 W	6099-1275
R217	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R218	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R219	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565
R220	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R221	Composition, 560Ω ±5% 1/4 W	6099-1565
R222	Composition, 910Ω ±5% 1/4 W	6099-1915
R223	Composition, 47Ω ±5% 1/4 W	6099-0475
R224	Composition, 20 kΩ ±5% 1/4 W	6099-3205
R225	Composition, 20 kΩ ±5% 1/4 W	6099-3205
R226	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R227	Composition, 12 kΩ ±5% 1/4 W	6099-3125
R228	Composition, 12 kΩ ±5% 1/4 W	6099-3125
R229	Composition, 220Ω ±5% 1/4 W	6099-1225
R230	Composition, 680Ω ±5% 1/4 W	6099-1680
R231	Composition, 220Ω ±5% 1/4 W	6099-1225
R232	Composition, 47Ω ±5% 1/4 W	6099-0475
R233	Composition, 390Ω ±5% 1/4 W	6099-1395
R234	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R235	Composition, 820Ω ±5% 1/4 W	6099-1825
R236	Composition, 330Ω ±5% 1/4 W	6099-1335
R237	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R238	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565
R239	Composition, 180Ω ±5% 1/4 W	6099-1185
R240	Composition, 560Ω ±5% 1/4 W	6099-1565
R241	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565
R242	Composition, 470Ω ±5% 1/4 W	6099-1475
R243	Composition, 47Ω ±5% 1/4 W	6099-0475
R244	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275
R245	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275
R246	Composition, 100Ω ±5% 1/4 W	6099-1105
R247	Composition, 15 kΩ ±5% 1/4 W	6099-3155
R248	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475
R249	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395
R250	Composition, 27Ω ±5% 1/4 W	6099-0275
R251	Potentiometer, composition, 100Ω ±20%	6040-0100
R252	Composition, 820Ω ±5% 1/4 W	6099-1825
R253	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275
R254	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275
R255	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R256	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685
R257	Composition, 47Ω ±5% 1/4 W	6099-0475
R258	Composition, 470Ω ±5% 1/2 W	6100-1475
R259	Composition, 10Ω ±5% 1/4 W	6099-0105
R260	Composition, 10Ω ±5% 1/4 W	6099-0105

REF NO	DESCRIPTION	PART NO
	RESISTORS (Cont)	
R261	Composition, 10Ω ±5% 1/4 W	6099-0105
R262	Composition, 10Ω ±5% 1/4 W	6099-0105
R263	Composition, 10Ω ±5% 1/4 W	6099-0105
R264	Composition, 4.7Ω ±5% 1/4 W	6099-9475
R265	Composition, 220Ω ±5% 1/4 W	6099-1225
R301	Composition, 1.8 kΩ ±5% 1/4 W	6099-2185
R302	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225
R303	Composition, 100Ω ±5% 1/4 W	6099-1105
R304	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275
R305	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R306	Composition, 27 kΩ ±5% 1/4 W	6099-3275
R307	Composition, 100Ω ±5% 1/4 W	6099-1105
R308	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275
R309	Composition, 1.8 kΩ ±5% 1/4 W	6099-2185
R310	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225
R311	Composition, 220Ω ±5% 1/4 W	6099-1225
R312	Composition, 1.8 kΩ ±5% 1/4 W	6099-2185
R313	Composition, 100Ω ±5% 1/4 W	
R314	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R315	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R316	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155
R317	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R318	Composition, 1 kΩ ±5% 1/4 W	6099-2105
R319	Composition, 100Ω ±5% 1/4 W	6099-1105
R320	Composition, 33Ω ±5% 1/4 W	6099-0335
R321	Composition, 10 kΩ ±5% 1/4 W	6099-3105
R322	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565
R323	Composition, 47Ω ±5% 1/4 W	6099-0475
R324	Composition, 820Ω ±5% 1/4 W	6099-1825
R325	Composition, 33Ω ±5% 1/4 W	6099-0335
	TRANSFORMERS	
T101	Adjustable, ferrite cup	5000-2821
T102	Adjustable, ferrite cup	5000-2822
T103	Adjustable, ferrite cup	5000-2823
T104	Adjustable, ferrite cup	5000-2824
T105	Adjustable, ferrite cup	5000-2824
T201	Adjustable, ferrite cup	5000-2811
T202	Adjustable, ferrite cup	5000-2812
T203	Adjustable, ferrite cup	5000-2813
T204	Adjustable, ferrite cup	5000-2814
T205	Adjustable, ferrite cup	5000-2815
T206	Adjustable, ferrite cup	5000-2816
T207	Adjustable, ferrite cup	5000-2817
T208	Adjustable, ferrite cup	5000-2818
T301	Adjustable, ceramic, iron core	1160-2290
T302	Adjustable, ceramic, iron core	1160-2310
T303	Adjustable, ceramic, iron core	1160-2320
T304	Adjustable, ceramic, iron core	1160-2440
	TRANSISTORS	
Q101	Type 2N3250	8210-1089
Q102	Type 2N1499A	8210-1499
Q103	Type 2N1499A	8210-1499
Q104	Type 2N708	8210-3089
Q105	Type 2N708	8210-3089
Q106	Type 2N1499A	8210-1499
Q107	Type 2N1499A	8210-1499
Q108	Type 2N708	8210-3089
Q109	Type 2N2188	8210-1045
Q110	Type 2N708	8210-3089
Q111	Type 2N2188	8210-1045
Q112	Type 2N2188	8210-1045

PARTS LIST (Cont)

REF NO	DESCRIPTION	PART NO
	TRANSISTORS (Cont)	
Q113	Type 2N708	8210-3089
Q114	Type 2N708	8210-3089
Q115	Type 2N708	8210-3089
Q201	Type 2N708	8210-3089
Q202	Type 2N708	8210-3089
Q203	Type 2N708	8210-3089
Q204	Type 2N2188	8210-1045
Q205	Type 2N1304	8210-1304
Q206	Type 2N1304	8210-1304
Q207	Type 2N1499A	8210-1499
Q208	Type 2N1499A	8210-1499
Q209	Type 2N1304	8210-1304
Q210	Type 2N708	8210-3089
Q211	Type 2N2369	8210-1052
Q212	Type 2N2369	8210-1052
Q213	Type 2N2188	8210-1045
Q214	Type 2N708	8210-3089
Q215	Type 2N708	8210-3089
Q216	Type 2N708	8210-3089
Q217	Type 2N708	8210-3089
Q218	Type 2N2218	8210-1028
Q219	Type 2N2218	8210-1028
Q301	Type 2N1499A	8210-1499
Q302	Type 2N708	8210-3089
Q303	Type 2N1499A	8210-1499
Q304	Type 2N708	8210-3089
Q305	Type 2N2188	8210-1045
Q306	Type 2N2188	8210-1045
	MISCELLANEOUS	
X101	Crystal 5-Mc	1213-0440
—	Assembly, etched board Master Frequency	1160-2750
—	Assembly, etched board Picket Fence	1160-2761
—	Assembly, etched board 42-Mc circuit	1160-2770



NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

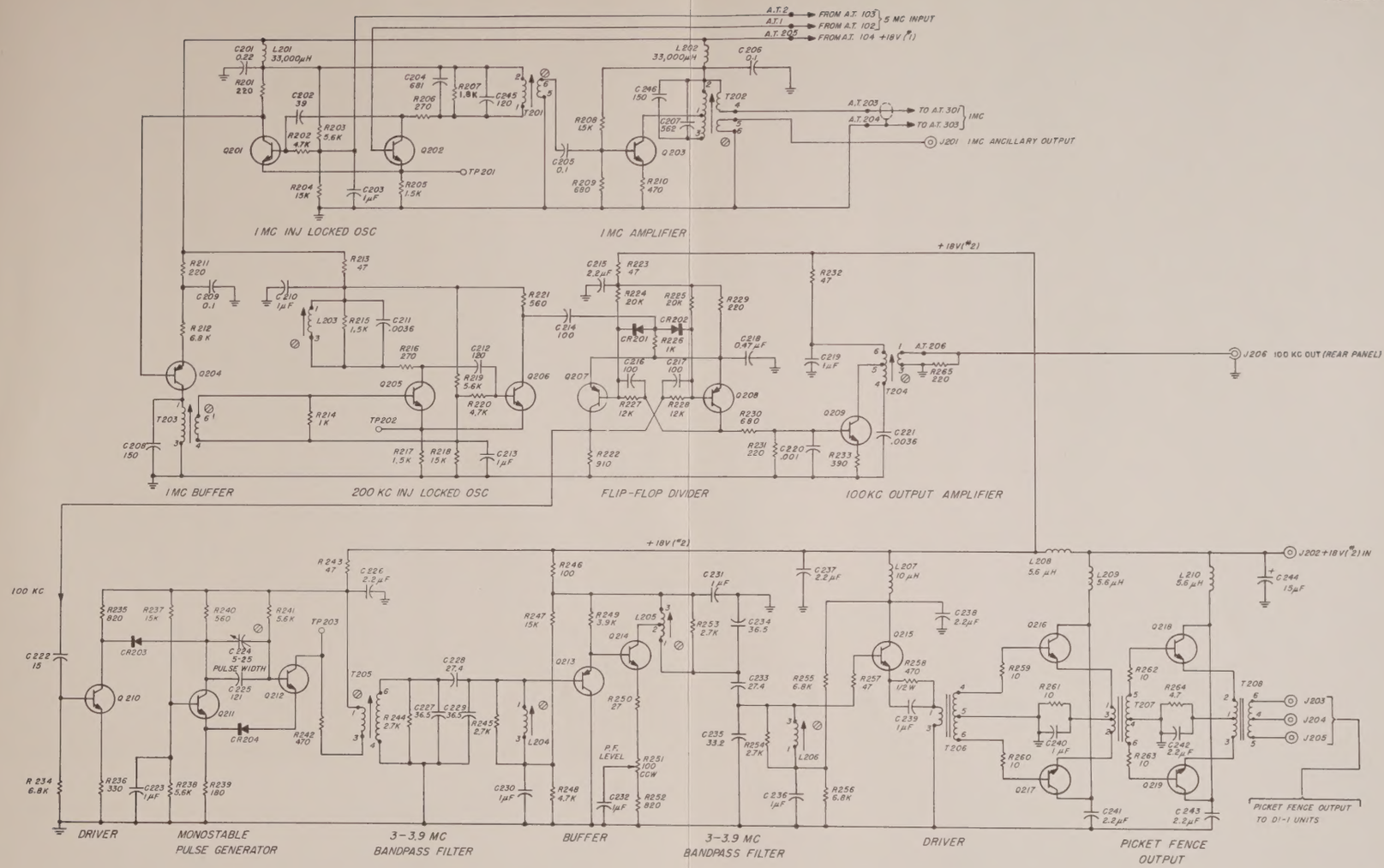


Figure CA-11.
Schematic diagram for Picket Fence Section.